handle with a strong leather covering. One illustration here reproduced represents a *corps à corps à la Japonaise*, and, judging from the photograph, it is allowable to combine a trip with a hit, as one fencer is trying to knock his opponent over with a hit at the neck, at the same time taking his leg from under him with a sort of jujitsu trip.

The last chapter describes the sumō or wrestling of the Japanese—to many a most repulsive spectacle on account of the enormously fat bodies of the particular class of men who follow this profession; but a fight between two expert sumōtori is for the Japanese an event of almost national importance, and they flock in thousands to the huge amphitheatre in the centre of which the tussle takes place. The second illustration shows two combatants in a crouching position waiting for a chance to spring at each other.

The last few pages of the book are devoted to jujitsu, but as nothing new is said on this subject and the photographs are very poor there is no need to enter into detailed description. For the rest, a very pleasant hour may be spent over the perusal of this interesting little book. E. W.

FIG. 2.—Tachi-ai, or watching for an opening. From "The Fighting Man of Japan."

THE MOTION OF THE MOON.[1]

PER ARDUA AD ASTRA should be the motto for a cultivator of the lunar theory. There is no austerer road to prove oneself a man of mettle. *Incredibile studium atque indefessus labor* was Euler's summary upon it, and improvement of method since Euler's time has diminished neither *studium* nor *labor*. The work now brought to completion has occupied Prof. Brown (and a computer) since 1895, almost to the exclusion of other researches, and for some years before that he was busied with developing its methods. Moreover, the present stage is only a level whence he can take breath to proceed.

It is a fact to remember in mathematical astronomy that problems mathematically identical are often astronomically opposite as the poles. The theory of the moon from a geometer's point of view is simply the theory of one of the planets. It is the special values of the constants alone which distinguishes the case. The astronomer seeks a correct ephemeris, but a mathematical instinct seeks to solve the question as a case of the problem of three bodies, and Delaunay's two enormous volumes will show what labours may be undertaken to obtain full literal development of the moon's coordinates which shall be approximate enough to meet the needs of the observer. Unfortunately the expressions when obtained are in many cases so imperfectly convergent that they give neither a solution of the three-bodies-problem nor do they surpass the observations in precision, as calculation should. It seems that unless some wholly new device is found we must be content to separate the problem into two parts, leaving literal developments for special mathematical researches throwing light upon the problem of three bodies, such as G. W. Hill's investigations of periodic moons of different mean motions, and making the developments essentially numerical when they are designed to form the basis for tables, although by so doing the former part loses all observational interest and the latter nearly all that is mathematical. Prof. Brown's theory is neither wholly numerical like that of Hansen nor wholly literal like that of Delaunay. The mean motion alone is treated as numerical, the other constants as eccentricities and inclination appearing in literal form. This was a plan Adams always urged, and from time to time he made considerable studies to give effect to it. When there otherwise remain four parameters according to powers of which each coefficient must converge, it is clearly an immense gain to omit a fifth when that fifth is answerable for all the worst cases of slow convergence; and while the mean motion may be considered known, it is hardly the case with the other constants, the lunar eccentricity, for example, and the ratio of the mean distances of the sun and moon being uncertain within the limits over which debate ranges, so that it is essential that the calculator should not be tied to a single set of elements at the outset.

Besides this idea Prof. Brown's research rests upon two clear and solid supports. First is the use of rectangular moving axes of reference, which he points out—and otherwise it seems to have passed from memory—was developed by Euler. But perhaps as much as anything his success is due to the brilliant transformation of the equations of motion given by G. W. Hill. It detracts not the least from Prof. Brown's achievement that his main ideas and methods are derived from earlier masters. The tools were ready to hand for one who had the learning and judgment to use them. Anyone who has faced a similar task knows that there remain abundant calls for resource and invention, as well as for comprehensive patience, in fitting given plans together and working them out abreast in every remote ramification of a subject, without fidgeting about "originality."

The work is not yet at a stage to put to proof by calculation of an ephemeris, which indeed would need the calculation of lunar places for a great many years backwards and forwards to prove that it is superior to Hansen, or to Hansen *plus* Newcomb. But even now it is almost certain that it will be so. First its methods are more intelligible and above

[1] "Theory of the Motion of the Moon." By Ernest W. Brown, F.R.S. In the Memoirs of the Royal Astronomical Society, vols. liii., liv., lvii.

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board than those of Hansen, and so there is a better chance of correcting the errors, which no mortal can altogether escape. Next the constants are not stereotyped, and if it is necessary to change them the effect can be made visible; and for a searching piece of evidence, Prof. Brown has shown already that his calculations remove the last shred of disagreement between the calculated and observed motions of the moon's apse. Finally, in a recent analysis of the Greenwich observations back to 1750, Mr. P. H. Cowell has given a most striking verification of all Prof. Brown's coefficients.

When Prof. Brown constructs his tables there is an error Hansen fell into which he may be trusted to avoid. In order to improve the agreement with observation, Hansen introduced a certain empirical element. An empirical correction is better than nothing, but it cannot be too clearly recognised that until it is furnished with a theoretical basis it is no more than a mathematical *memoria technica*. Certainly its place is not in a set of tables, the sole function of which is to expose correctly and fully the consequences of a clear theory and definite elements, with the view of testing the one and amending the others. R. A. S.

THE CONTROL OF THE GAS SUPPLY OF THE METROPOLIS.

THE notification of the metropolitan gas referees just issued differs in several respects from that for the preceding year, a change necessitated by the provisions of the London Gas Act, 1905. For some years past the London gas companies have been asking for the revision of their Acts, with reference more especially to the system of testing to which their gas is subjected. In the early days of gas supply, when there was free competition and the consumer had the choice of more than one company, no testing was regarded as necessary, but when, owing to the amalgamation and consolidation of the gas companies, the supply became a monopoly, a system of testing the purity and illuminating power of the gas was instituted. The whole of the arrangements for testing London gas, with the exception of one or two points specially laid down in some of the Acts, are left to the discretion of the gas referees, originally appointed under the City of London Gas Act, 1868. It was alleged by the companies that the requirements of the referees were too stringent and out of touch with the modern developments of gas manufacture. In January, 1904, a departmental committee of the Board of Trade was appointed to inquire and report as to the whole system of gas-testing in the metropolis. At the inquiry the committee heard evidence from the gas referees, and from representatives of the London County Council, the Corporation of London, and each of the three gas companies concerned. It is noteworthy that no actual consumer was heard, although on one of the most important points dealt with by the committee, the question of sulphur impurity, the committee in its report says, "It does not appear that any complaints are made by the inhabitants of other districts on the ground that the gas thus unpurified causes injury to health or is more destructive to articles such as leather, &c., than it is supposed to be in London."

The report of the committee was almost wholly favourable to the companies. The mode of testing for sulphuretted hydrogen is to be relaxed, a test lasting three minutes being substituted for one spread over 15 hours, and all sulphur compounds other than sulphuretted hydrogen may be, and henceforth will be, left in the gas. The evidence of the companies as to the amount of sulphur impurity under the new conditions was to the effect that an average of 35 grains per 100 c.ft. or under might be expected, with the possibility of an occasional rise to 40, the maximum under the Acts just repealed being 17 grains in summer and 22 grains in winter. The figures for the amount of sulphur present in the gas supplied by the South Metropolitan Company during December last throw an instructive light on the value of this evidence, the weekly average increasing from 40·8 to 44·6 grains per 100 c.ft. with a single maximum of 61·3. On one occasion the Commercial Gas Company surpassed even this figure with a maximum of 70·2. It is clear, therefore, that the gas now to be supplied to London may contain about double the amount of sulphur contemplated by the departmental committee, and this is of interest in view of the fact that a Bill is now before Parliament promulgated by various provincial gas companies asking to be placed in the same position as the London companies as regards the removal of sulphur restrictions.

In one point the report of the departmental committee was favourable to the consumer. It recommended that the standard burner for testing the illuminating power of all qualities of gas should be the burner at present in use, the Sugg's London Argand No. 1, the gas to be burnt at the rate of five feet per hour. The gas referees in their present notification disregard this recommendation, and prescribe a burner devised by the engineer to the South Metropolitan Gas Company. The practical effect of this will be to increase the nominal illuminating power of the gas supplied by those companies having a 14-candle standard. It will be seen, therefore, that the new conditions are wholly favourable to the companies.

There remains one new point in the gas referees' notification, the prescription of a method of determining the calorific power of gas. The calorimeter, which has been devised by Mr. C. V. Boys, appears to be a distinct advance over its predecessors of the same type, and when it is installed in the testing stations systematic measurements of the calorific power of London gas will, for the first time, be on record, and will be available for the next battle on the gas question, calorific power *v.* illuminating power.

PROF. C. J. JOLY, F.R.S.

THE lamentable death of Prof. C. J. Joly at the early age of forty-one closes a career which was likely to influence favourably the mathematical side of astronomy. But his tenancy of the post of Royal Astronomer of Ireland and Andrews Professor in the University of Dublin was, alas! too short for him to make his individuality felt in the science with which he was connected by his occupancy of the chair, that has of late been held by Sir Robert Ball and Dr. Arthur Rambaut. The traditions of the office, and it may be the interrupted work of these astronomers, would naturally compel him for a time to follow certain definite lines which the previous occupants of the chair had approved. But his work in the department of pure and applied mathematics was of a high order and affords abundant evidence of originality and capacity.

From the time that Prof. Joly entered Trinity College, Dublin, his academic career was marked by his devotion to natural science, and mathematical scholarships and studentships were the natural preliminaries that led to a later fellowship. In this position he distinguished himself as a successful teacher of advanced science, but in 1897, when Dr. Arthur Rambaut was appointed to the office of Radcliffe observer, Dr. Joly

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